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Assessment of the Effects of Protein Malnutrition on Cerebellar Purkinje Cells in Adult Rats

Gholamreza Hassanzadeh [1,3], Fatemeh Attari [2,3,*], Mahnaz Azarnia [4], Seyed Mohammad Hossein Noori Mogahi [1], Hamid Hamdollah Zadeh [4], Maryam Javadi [5], Rostam Ghorbani [6], Alireza Karambaksh [1]

[1] Department of Anatomy, School of Medicine, Tehran University of Medical Sciences, Tehran, IR Iran
[2] Shefa Neuroscience Research Center, Khatamolanbia Hospital, Tehran, IR Iran
[3] Department of Neuroscience, School of Advanced Medical Technology, Tehran University of Medical Sciences, Tehran, IR Iran
[4] Department of Biology, Faculty of Science, Kharazmi University of Tehran, Tehran, IR Iran
[5] Department of Nutrition and Dietary Therapy, School of Medicine, Qazvin University of Medical Sciences, Qazvin, IR Iran
[6] Department of Anatomy, School of Medicine, Kermanshah University of Medical Sciences, Kermanshah, IR Iran

Corresponding author: Fatemeh Attari, Department of Neuroscience, School of Advanced Medical Technology, Tehran University of Medical Sciences, Tehran, IR Iran. Tel: +98-2183553910, Fax: +98-2183553920, E-mail: feriattari@gmail.com.

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Background: Purkinje cells play a critical role in the normal function of the cerebellum and are highly susceptible to a variety of abnormal conditions including protein deprivation, which may lead to brain dysfunction.
Objectives: The aim of this study was to investigate the effects of low-protein diet on the frequency, diameter and distance between Purkinje cells of the cerebellum.
Materials and Methods: Twenty two male Wistar adult rats were randomly divided into two groups including animals with normal diet and trial animals that underwent protein deprivation for ten months. Then the animals were sacrificed with aldehyde solutions and their cerebella were removed for sectioning. Forty μm coronal sections were prepared and stained with Hematoxylin and Eosin (H & E) and neutral red. Morphometeric parameters including the frequency and diameter of Purkinje cells and distances between them were studied by light microscopy. Statistical analysis was done with Mann-Whitney U test.
Results: The low-protein group did not gain weight as much as the control group ($P < 0.05$). The diameter of Purkinje cells was 151 ± 8 μm in control group compared to 179.5 ± 11 μm in low-protein group ($P < 0.05$). The mean number of Purkinje cells was 14.2 ± 4 in control group and was 8.3 ± 7 in low-protein group ($P < 0.05$). Distances between Purkinje cells was 363.9 ± 12 μm in control group, but increased to 472.1 ± 27 μm in low-protein group ($P < 0.05$).
Conclusions: Considering that neuronal function highly depends on environmental conditions, any adverse alteration may affect the function and morphology of neurons. In this regard, our results showed the adverse effects of protein malnutrition on the morphology of the Purkinje cells of cerebellum.

Keywords: Central Nervous System; Purkinje Cells; Cerebellum; Diet, Protein-Restricted; Malnutrition

1. Background

Cerebellum is a brain area that is critical for the fine adjustment of motor output and for the formation of several types of motor memories (1). Purkinje cells present a unique cellular profile in the cerebellum and are the only output cells of the cerebellar cortex. Interestingly, Purkinje cells are highly susceptible to a variety of abnormal conditions (2). In human, Purkinje cells are affected in a variety of diseases ranging from malnutrition and toxic exposure (i. e. alcohol, lithium), to autoimmune diseases and genetic mutation of amino acids. Regarding the importance of dietary protein, many studies have assessed the effects of protein malnutrition on different parts of the brain (3). Impairment of CNS following protein deficiency has been extensively studied and this deprivation leads to deleterious effects upon cerebral structures (4).

Protein deprivation can cause many direct deleterious effects in the brain such as loss of brain weight (5-7), alteration of hippocampal formation (8), impairment of neurotransmitter systems (9, 10), changes in protein phosphorylation (11) and deficits in cognitive functions (12). Experimental protein malnutrition was induced in groups of young juvenile squirrel monkeys by feed-

Implication for health policy/practice/research/medical education:
We conducted this experimental study in order to evaluate the effects of malnutrition on cerebellar purkinje cells among rats, and we recommend that our study may be expanded to humans.